

## SAGA OF A SMALL SCIENCE CENTER

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### THE SETTING

Pune is the cultural capital of Maharashtra, India. In the past 150 years, this city has produced a string of social reformers, whose ideas and actions have had a deep impact on India's development. These luminaries include, among others, Mahatma Phule (1827-1890)—first to raise the voice of the subjugated, poorest castes; Gopal Krishna Gokhale (1866-1915)—Gandhi's political mentor; the firebrand nationalist Bal Gangadhar Tilak (1856-1920); Maharshi Karve (1858-1962)—pioneer of women's education; and Hamid Dalwai (1932-1977)—founder of Muslim Satyashodhak to stimulate reform in his community. It is fitting for such a historical context that further initiatives to reform and enhance social and individual life continue to emerge. In this chapter I describe one such development, which culminated in the establishment of a small science center in the development of which it has been my privilege and pleasure to play an active role. Following is a brief overview of how and why the initiative evolved.

## THE BEGINNING

Crucial to the development of the Science Center was the prior initiative by renowned astrophysicist Jayant V. Narlikar<sup>1</sup> to create, in 1988, the Inter-University Center for Astronomy & Astrophysics (IUCAA) within the Savitribai Phule Pune University. Professor Narlikar is India's most celebrated scientist, having won the second highest civilian award—Padma Vibhushan. Two decades earlier he had won the Kalinga Award—UNESCO's highest recognition for science popularization. As part of his research institute, his dream was to set up a Children's Science Center. Why? To offer children at an early age the opportunity to experience the joy, and develop the love, of science. A large donation from Smt. Sunita Deshpande—the wife of his late friend P. L. Deshpande, a cultural icon in India—turned the dream into reality. The children's Exploratory Science Center or '*Muktangan Vidnyan Shodhika*' (MVS) was inaugurated in 2004 by Prof. Yashpal, a fellow Kalinga Awardee who shared Jayant Narlikar's vision of science. Right from its inception, IUCAA had an active public outreach program. Every second Saturday there was a popular science lecture/demonstration for some 1000 students and teachers from over a 100 schools from Pune.

My own academic and engineering background is from the Indian Institute of Technology Kanpur in Uttar Pradesh with many years of grassroots experience in popular science. Like many idealists in the 1970s, I had left a well-paying job to plunge into social change working for two decades with various People's Science Movements. In 2003, I was invited by Professor Narlikar to become the first coordinator of the Science Center, initially for a period of six months, but ultimately I spent 11-years at the Children's Science Center. I was soon joined by Vidula Mhaikar, a microbiologist with four years PostDoc experience at Stanford, and by Ashok Rupner, who brought in a decade of experience of working in a Mobile Science Lab. This was all made possible through funding from the philanthropic Tata Trust. This core group continued for almost a decade, with support from occasional part-time volunteers who pitched in for short periods of time.

India is a large country with a population of more than 1.3 billion people. The education system is highly segregated with badly run government schools for the poor and private well run schools for the rich. Irrespective of the school, all children learn science by rote—mugging up definitions and formulae. The rich schools have well-equipped science labs with burettes, pipettes, and test tubes. But all this fancy equipment often lies unused, locked in cupboards and laden with a layer of dust. Most teachers come from a mutilated system where they have never 'dirtied their hands with experiments.' So, they prefer the age-old chalk-and-talk method.

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<sup>1</sup> A 22-minute Walk the Talk interview with Prof. Narlikar is available at <https://www.ndtv.com/video/shows/walk-the-talk/walk-the-talk-with-renowned-astrophysicist-professor-jayant-narlikar-372830>.

## THE HOSHANGABAD SCIENCE TEACHING PROGRAMME (HSTP)

The 1970's were full of positive political turmoil—student uprisings, civil rights and anti-war movements. In this decade the environment and women's movements made rapid strides. Sensitive scientists asked fundamental questions: “Should we work for human welfare or design bombs and missiles?” The defining political slogan was “Go to the people, love them, live with them, start from what they know, and build on what they have.” It was against this backdrop that the ‘Hoshangabad Science Teaching Programme’ (HSTP) emerged, initiated by Anil Sadgopal, to revitalize science learning in village schools where there were no labs.

This pioneering program started with 16 schools but soon spread to over a thousand village schools in Central India. The HSTP drew its inspiration from the Nuffield Science Program in England. It emphasized the ‘discovery method’ and ‘learning by doing.’ Many progressive and creative scientists from colleges and universities across India lent support to this program. The HSTP was a wonderful partnership between a local group (a Non-Governmental Organization) and the state government. Teachers and children actively participated in designing low-cost experiments, based on local, easily accessible materials. It unleashed mass creativity and experimentation. The credo was, “think differently; look at your milieu critically.” So, children substituted ‘dissecting needles’ with long Acacia thorns plucked from local bushes. When the indicator ‘phenolphthalein’ could not be bought, a teacher dissolved a tablet of the commonly available laxative “Vaculax” (which contained 0.2 mg of phenolphthalein) in water to conduct a



Figure 1: Two-dimensional and three-dimensional matchstick assemblages

successful experiment. Bicycles are ubiquitous on village roads. The pieces of bicycle valve tube (a thin black flexible tube) were used as ‘joints’ and matchsticks as members to make an array of two- and three-dimensional structures. A simple, working model of the DC motor was devised using a torch battery, magnet and insulated copper wire! These experiments captured the imagination of children. With everyday, local materials it was easy for the children to relate science to their daily, real-life affairs. Science could be done without lab coats and outside the standard labs.

The 1990s saw the World Bank (WB) sponsored District Primary Education Program (DPEP) pushed across India. The DPEP was touted as a panacea for India's educational ills. The entire political class smelt quick dollars in this program. The home grown, low-cost Hoshangabad Science Teaching

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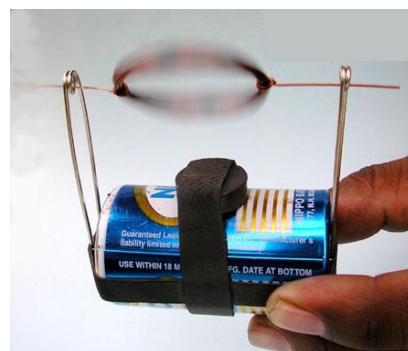


Figure 2: Simple DC motor

Program—with its vast experience, was the only real threat to the WB sponsored DPEP. So, in 2002 the state government shut down the HSTP! This conclusively demonstrated that any creative science program can only survive under the political support of the state government. Once the political umbrella is withdrawn the program will collapse and die.

### A TYPICAL DAY IN THE CENTRE

The HSTP taught us many ‘scientific’ and ‘political’ lessons which were incorporated in the Science Activity Center at IUCAA, Pune. Two days a week we conducted free workshops for school children and teachers. Any school could register and bring 50 children to the Science Center for an amazing 3-hour experience. During these sessions children could see many improvised, working science models, made from plastic bottles, Tetra Pak cartons, matchboxes, broomsticks, plastic straws, etc. The children would also make many things with their own hands. For example they would make the Straw Flute, Sprinkler, and a simple Electric Motor; fold a Cricket Cap from a newspaper and make a dynamic Spinner from a broomstick. The children took home their creations. For once they got a taste and feel for ‘good’ science. These workshops became vastly popular. Schools had to be booked two months in advance.

The Electric Motor and Generator are part of the class ninth science curriculum. Children mechanically mug-up Faraday’s laws of Induction to pass exams. This way their knowledge is very superficial. There is no deep insight or understanding. So to

assemble an electric motor from scratch, and make it work, was for children an unforgettable experience. You could see the joy of discovery ‘sparkling’ in their eyes. Over the years thousands of children also made the ‘Syringe Generator.’ For this they wrap 1000-turns of insulated copper wire on the plastic barrel of a disused syringe to make the coil and then attach the coil ends to a LED. Finally they place a strong Neodymium Magnet inside the syringe barrel. On shaking the magnet the LED glows! The moving magnetic field produces a small current in the coil and lights up the LED. For the first time they produced current! It helps them relate theory to practice. This empowers children. A girl from a poor unelectrified village is likely to exclaim: “Today I light one LED; someday I will light up my village!”

We conduct workshops on only two days a week. What do we do on other days? We read, listen to inspiring TED talks, great music and meet many inspired people. Every day we design new experiments from trash. Modern society produces mounts of junk. We use Tetra Pak cartons,

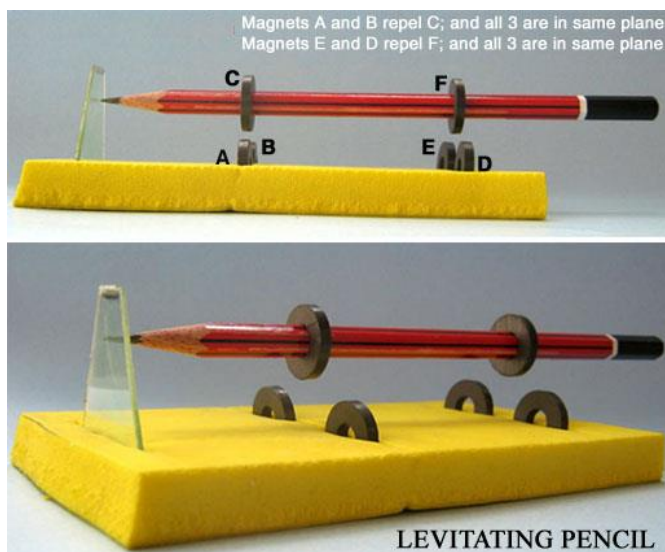


Figure 3: Levitating pencil



plastic bottles, newspapers, cardboard cartons, caps, old pens, and other throwaway stuff. Recycling and environmental sensitivities are inbuilt in our designs. We always ask, “Can we replace this expensive material with something low-cost or throwaway stuff?” Today we have 50 models made from waste Tetra Pak material, and over a 100 for which we use old plastic bottles! These models can be made by the poorest children who can never afford expensive science kits! Our message is: pick up rubbish—and we will help you make beautiful fun toys. Most school science has outdated curricula that are totally out of sync with societal needs. In India we are never far away from abject poverty. We want our science toys to help children in Asia, Africa and Latin America. We wish to reach out to the poorest children on earth!

## MAIN ACTIVITIES

The ethos of the Science Center is people centric, to help children who need it most—especially children from the oppressed section who study in Government and Municipal schools. For seven years we ran a twice weekly Science Club in the only school located in 400-acre Pune University Campus—the Vidyapeeth Shaala.

What else did we do? We document science models and toys in simple but profusely illustrated books. Today we have 20 activity books with beautiful line drawing. Most books have been translated and published in five or six Indian languages and have gone into multiple editions. The Fondazione Montessori—the Montessori Foundation in Italy is publishing an anthology from our various books in Italian for the children there. The city of Pune has an enormous appetite for science. Its people have abundant energy to do meaningful things. The Center gets many visitors and some of them contribute significantly. We seize this wonderful opportunity and build upon the goodness of people. They have translated many books on education, science, math and the environment in the local language Marathi. In ten years over a 100 world class books were translated in Marathi. Educational classics like *Summerhill* by A. S. Neill; *Free at Last* by Daniel Greenberg (Sudbury School); *Totto-chan* by Tetsuko Kuroyangi; *Teacher* by Sylvia Ashton Warner; and *Danger: School* by Paulo Freire’s group. In science we have the *VSO Science Teachers and Math’s Teachers Handbooks*, the *UNESCO Sourcebook for Science Teaching*, along with a series of 36 books by the great Isaac Asimov: *How did we find out about ... Black Holes, Germs, Vitamins, Antarctica, and Solar Energy* etc. These lucid, wonderful books on the history of science were written by the world’s greatest science writer. Marathi was the first language in which this entire series was translated, followed by Telugu and Hindi.

In 2003 the website [www.arvindguptatoys.com](http://www.arvindguptatoys.com) was set up. Initially, all our own science activity books were uploaded. Gradually other books were scanned and added. Slowly the corpus of books grew. Today the website hosts a large collection of 5,500 books in Marathi, Hindi and English. Many of these books have been out of print for years and cannot be bought. Every day 20,000 books get downloaded for free! It just shows the hunger for good books among our people.

In 2005, a young and dynamic volunteer Monil Dalal from India's premier National Institute of Design interned with us during summers. He documented all our teaching aids in sequential photographs. In keeping with the dictum that "a picture speaks more than a thousand words," we labeled, captioned and uploaded these photographs. The photos help children make science models. The photos are easier and clearer to follow than just written instructions.

In India the National Council for Education Research and Training (NCERT) is the apex body which designs curriculum. We collaborated and made over 125 videos on simple science models with the TV wing of the NCERT. These programs were dubbed in many Indian languages and beamed on the National TV channel *Doordarshan*. India has hundreds of TV channels. But *Doordarshan* has the largest reach and is viewed by millions in far flung villages.

There is a dearth of good educational material in the regional languages—especially in Hindi—the language spoken in 5 states. Close to 500-million people speak Hindi but there is acute scarcity of good books on science, math, the environment, and children's books. We have helped translate over 175 books in Hindi. This includes classic books like *Chemical History of a Candle* by Michael Faraday; *Soap Bubbles* by C. V. Boys; *The Autobiography of Charles Darwin*; and *The UNESCO Source Book of Science in the Primary School* by Harlen and Elstgeest, *Romping in Numberland* by P. K. Srinivasan and many other world class books. Most children in India do not have access to public libraries or supplementary books. Apart from school text books they cannot afford to buy other books. So, the digitized books made available online for free have helped many.

A major breakthrough took place in May 2009. A young social activist, Sourabh Phadke, taught us how to make short videos using a digital camera. He enthusiastically told us, "It's quite easy. Shoot short clips on the digital camera, weave them in Movie Maker—which came with Windows X software, and then overlay your voice using a small mike. Then upload the videos on YouTube." The training took less than half an hour. Soon Ashok internalized the process. In seven years he has single-handedly shot 970 videos. In June 2009, we produced and uploaded our first video—*BALANCING NAILS*. This 1-minute video showed how to balance a dozen nails on the head of one vertical nail. Since then we have never looked back. In April 2016—six and a half years later, we have 7000 videos in 20 different languages with a viewership of more than 47-million! Google (owners of YouTube) said that our channel was the second largest channel of educational videos from India! This was indeed a compliment considering that all this was done with minimal resources. Our room in the Science Center measures just 400 sqft (37 m<sup>2</sup>)!

These videos have been dubbed in many languages by volunteers. Prabhakar K. Nanavati—a people's science activist—has dubbed 900 science videos in Kannada. Today children in far flung villages of Karnataka can access these videos in their native language Kannada through mobile phones. Another wonderful volunteer was Breezy Ocana Flaquer. Breezy came as a Post Doc student and visited our center during her first week in Pune. She originally hails from the Dominican Republic. As a sensitive person—coming from a relatively poor country—she saw

immense possibilities in these Toys from Trash. She dubbed over 300 videos in her native language Spanish. Spanish is spoken in over 26 countries throughout the world. Today millions of children in Latin America have seen the Toys from Trash videos in Spanish. We have over 200 videos in Chinese, another 150 in Russian.

However, we have not been lucky with several Indian languages. We have just a few videos dubbed in Bengali, Oriya and Punjabi. We wish our videos were dubbed in Nepalese. Nepal is a poor country, struck by a massive earthquake in 2015. The videos in Nepalese would help thousands of children and teachers in Nepal. Similarly, the videos in Bengali would not only help learners in West Bengal but also in Bangladesh.

As of Jan 2016 we have 930 videos in English. These videos have been divided into 22 broad categories like Air, Water, Math, Electricity, Magnetism, Paper Toys etc. There are some novel categories like Toys from Trash and Pumps from the Dump. We have designed and documented over 30 different kinds of Pumps—which can inflate a balloon, or throw water 15-feet away, sprinkle water, etc. All these pumps use simple film can bottles, bicycle tubes, straws, bicycle spokes, etc. Children start with simple pumps and graduate on to difficult ones. In the process of assembling and making them work children get a very good ‘feel’ about valves and all else which goes into making a good pump.

Do children really learn science with these toys? Teachers / parents often lament that children get so engrossed in these projects that they do not pay much attention to their textbooks. Where is the science in all these toys? Will they help in children scoring high marks, or in clearing stiff entrance tests? The kids have loads of fun, but are they really learning science? Libertarian pedagogues have asked these questions for centuries. Play is primordial and children are born to play. Good learning takes place in an atmosphere of fun and joy. Great pedagogues like Erik Erikson, Lev Vygotsky and Jean Piaget sincerely believed that children’s play is very serious business. Summerhill’s founder A. S. Neill said, “I would rather see a school produce a happy street cleaner than a neurotic scholar.”<sup>2</sup> Children who play remain happy. They do not invent missiles and guns when they grow up. Happy people do not hurt or kill others. We sincerely believe in making children (especially the poor) happy by helping them make their own toys. Because there will be no peace on earth unless there are happy children!

**Epilogue:** *Arvind Gupta and Vidula Mhaikar quit the Science Center in Dec 2014. Arvind Gupta quit because of his medical condition. Vidula became the Director of the Garware Children’s Center in Pune. Ashok Rupner is the new coordinator of the Science Center. Work continues, as there is much left that remains to be done.*

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<sup>2</sup> [https://archive.org/stream/Summerhill-English-A.S.Neill/summerhill\\_djvu.txt](https://archive.org/stream/Summerhill-English-A.S.Neill/summerhill_djvu.txt)